RICOH

OUTPUT CAPACITOR-LESS/LOW VOLTAGE 200mA LDO REGULATOR

NO.EA-181-111020

OUTLINE

The RP107x Series are CMOS-based LDO regulators featuring 200mA output.

Since the output capacitor and noise bypass capacitor are able to be reduced and the packages are small DFN(PLP)1212-6, WLCSP-4-P5, and SC-88A, high density mounting on boards are possible. The input voltage (V_{IN}) is as low as Min.1.4V and the output voltage can be set from 1.0V.

Supply current is as low as 9.5μA compared to existing lines. The CE pin can switch the regulator to standby mode.

FEATURES

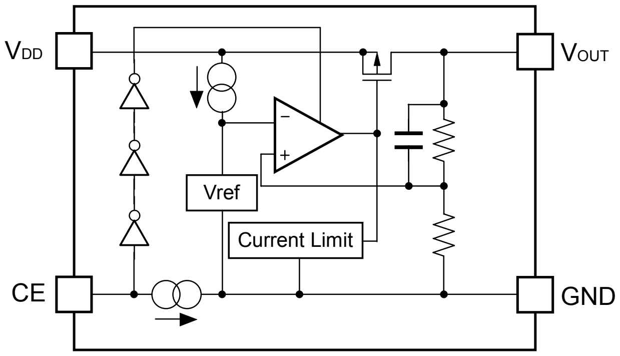
- Supply Current ....Typ. 9.5μA
- Standby Mode ....Typ. 0.1μA
- Dropout Voltage...Typ. 0.27V (I_{OUT}=200mA, V_{OUT}=3.0V)
- Ripple Rejection ....Typ. 70dB (f=1kHz, V_{OUT}≤1.2V)
  Typ. 65dB (f=1kHz, 1.2V<V_{OUT}<2.2V)
  Typ. 60dB (f=1kHz, V_{OUT}≥2.2V)
- Temperature-Drift Coefficient of Output Voltage ....Typ. ±100ppm/°C
- Line Regulation ....Typ. 0.02%/V
- Output Voltage Accuracy..±1.0%
- Packages..WLCSP-4-P5, DFN(PLP)1212-6, SC-88A, SOT-23-5
- Input Voltage Range...1.4V to 5.25V
- Output Voltage Range..1.0V to 4.2V (0.1V steps)
  (For other voltages, please refer to MARK INFORMATIONS.)
- Built-in Fold Back Protection Circuit.............................Typ. 50mA (Current at short mode)
- Output capacitor free and noise bypass capacitor free

APPLICATIONS

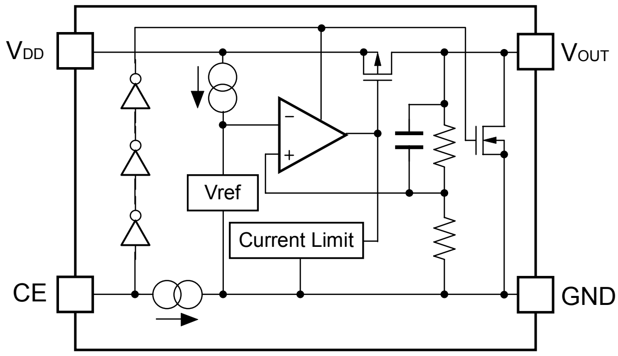
- Power source for portable communication equipment.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipment.
- Power source for home appliances.

BLOCK DIAGRAMS

RP107xxxxB



RP107xxxxD



SELECTION GUIDE

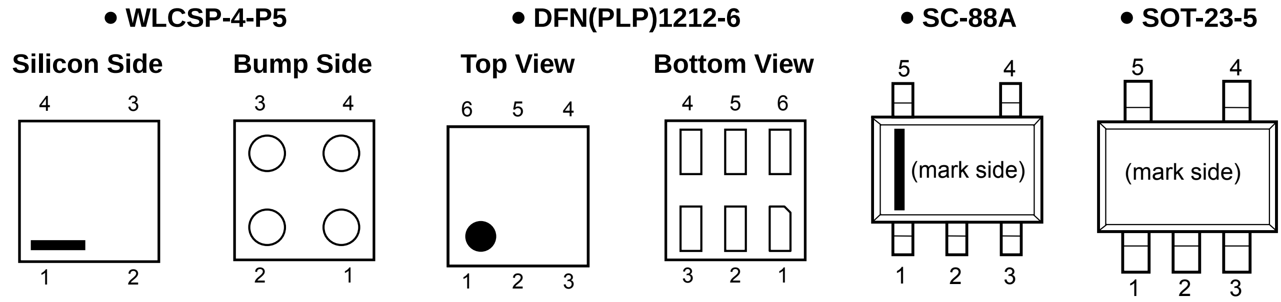
The output voltage, auto discharge function, package, and the taping type, etc. for the ICs can be selected at the user's request.

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
RP107Zxx1∗-TR-F	WLCSP-4-P5	5,000 pcs	Yes	Yes
RP107Kxx1∗-TR	DFN(PLP)1212-6	5,000 pcs	Yes	Yes
RP107Qxx2∗-TR-FE	SC-88A	3,000 pcs	Yes	Yes
RP107Nxx1∗-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes

xx: The output voltage can be designated in the range from 1.0V(10) to 4.2V(42) in 0.1V steps.
(For other voltages, please refer to MARK INFORMATIONS.)

∗ : CE pin polarity and auto discharge function at off state are options as follows.
(B) "H" active, without auto discharge function at off state
(D) "H" active, with auto discharge function at off state

PIN CONFIGURATIONS



PIN DESCRIPTIONS

- **WLCSP-4-P5**

Pin No	Symbol	Pin Description
1	V_{DD}	Input Pin
2	CE	Chip Enable Pin
3	GND	Ground Pin
4	V_{OUT}	Output Pin

- **DFN(PLP)1212-6**

Pin No	Symbol	Pin Description
1	NC	No Connection
2	GND	Ground Pin
3	CE	Chip Enable Pin
4	V_{DD}	Input Pin
5	NC	No Connection
6	V_{OUT}	Output Pin

- **SC-88A**

Pin No	Symbol	Pin Description
1	CE	Chip Enable Pin
2	NC	No Connection
3	GND	Ground Pin
4	V_{OUT}	Output Pin
5	V_{DD}	Input Pin

- **SOT-23-5**

Pin No	Symbol	Pin Description
1	V_{DD}	Input Pin
2	GND	Ground Pin
3	CE	Chip Enable Pin
4	NC	No Connection
5	V_{OUT}	Output Pin

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	6.0	V
V_{CE}	Input Voltage (CE Pin)	–0.3 to 6.0	V
V_{OUT}	Output Voltage	–0.3 to V_{IN}+0.3	V
I_{OUT}	Output Current	400	mA
P_D	Power Dissipation* (WLCSP-4-P5)	278	mW
	Power Dissipation* (DFN(PLP)1212-6)	400	
	Power Dissipation* (SC-88A)	380	
	Power Dissipation* (SOT-23-5)	420	
T_{opt}	Operating Temperature Range	–40 to 85	°C
T_{stg}	Storage Temperature Range	–55 to 125	°C

∗) For Power Dissipation, please refer to PACKAGE INFORMATION.

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the life time and safety for both device and system using the device in the field.
The functional operation at or over these absolute maximum ratings is not assured.

RECOMMENDED OPERATING CONDITIONS (ELECTRICAL CHARACTERISTICS)

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

ELECTRICAL CHARACTERISTICS

- **RP107xxxxB/D**

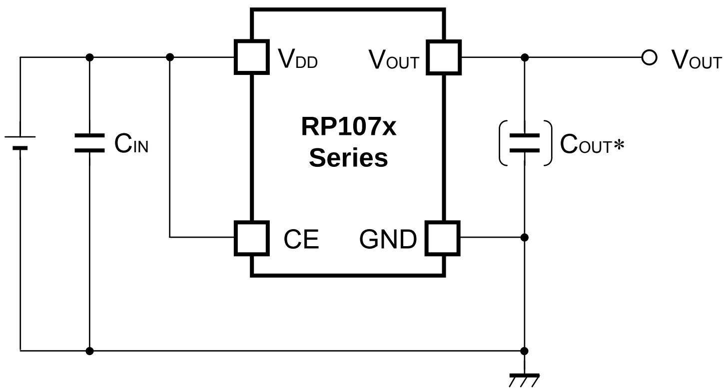
V_{IN}=Set V_{OUT}+1.0V, I_{OUT}=1mA, C_{IN}=C_{OUT}=0.1µF, unless otherwise noted.

The specification in $\boxed{}$ is checked and guaranteed by design engineering at −40°C≤Topt≤85°C. Topt=25°C

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	Topt=25°C	V_{OUT} > 2.0V	×0.99		×1.01	V
			V_{OUT} ≤ 2.0V	−20		+20	mV
		−40°C ≤ Topt ≤ 85°C	V_{OUT} > 2.0V	$\boxed{×0.980}$		$\boxed{×1.015}$	V
			V_{OUT} ≤ 2.0V	$\boxed{−40}$		$\boxed{+30}$	mV
I_{OUT}	Output Current			$\boxed{200}$			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	1mA ≤ I_{OUT} ≤ 200mA			25	$\boxed{50}$	mV
V_{DIF}	Dropout Voltage	I_{OUT}=200mA	1.0V ≤ V_{OUT} < 1.1V		0.64	$\boxed{0.92}$	V
			1.1V ≤ V_{OUT} < 1.2V		0.59	$\boxed{0.84}$	
			1.2V ≤ V_{OUT} < 1.5V		0.55	$\boxed{0.76}$	
			1.5V ≤ V_{OUT} < 2.0V		0.44	$\boxed{0.60}$	
			2.0V ≤ V_{OUT} < 2.6V		0.35	$\boxed{0.49}$	
			2.6V ≤ V_{OUT}		0.27	$\boxed{0.36}$	
I_{SS}	Supply Current	I_{OUT}=0mA			9.5	$\boxed{25}$	µA
Istandby	Standby Current	V_{CE}=GND			0.1	3.0	µA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	Set V_{OUT}+0.5V ≤ V_{IN} ≤ 5.0V			±0.02	$\boxed{±0.20}$	%/V
RR	Ripple Rejection	f=1kHz (V_{OUT}≤1.2V) f=1kHz (1.2V<V_{OUT}≤2.2V) f=1kHz (V_{OUT}≤1.2V) Ripple 0.2Vp-p, V_{IN}=Set V_{OUT}+1V, I_{OUT}=30mA (In case that V_{OUT}≤1.2V, V_{IN}=2.2V)			70 65 60		dB
V_{IN}	Input Voltage			$\boxed{1.4}$		$\boxed{5.25}$	V
$\Delta V_{OUT}/\Delta$Topt	Output Voltage Temperature Coefficient	−40°C ≤ Topt ≤ 85°C			±100		ppm/°C
I_{SC}	Short Current Limit	V_{OUT}=0V			50		mA
I_{PD}	CE Pull-down Current				0.1		µA
V_{CEH}	CE Input Voltage "H"			$\boxed{1.0}$			V
V_{CEL}	CE Input Voltage "L"					$\boxed{0.4}$	V
R_{LOW}	Low Output Nch Tr. ON Resistance (of D version)	V_{IN}=4.0V V_{CE}=0V			30		Ω

All of units are tested and specified under load conditions such that Tj≈Topt=25°C except for Ripple Rejection, Output Voltage Temperature Coefficient.

TYPICAL APPLICATION



TECHNICAL NOTES

When using these ICs, consider the following points:

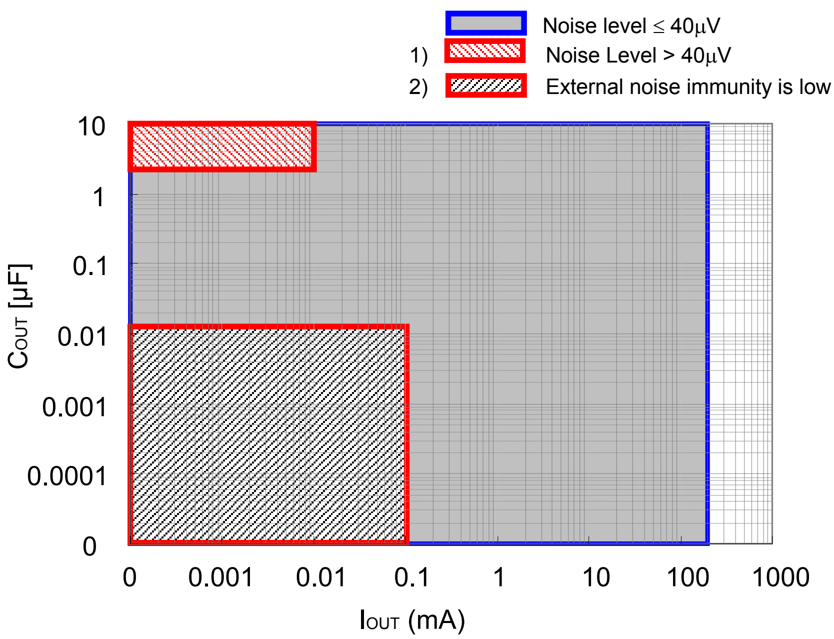
Phase Compensation*)

In these ICs, phase compensation is made for securing stable operation even if the load current is varied. If load variation is very large, it is better to attach the output capacitor in the range from 0.1µF to 10µF. If the tantalum capacitor is selected and the ESR (Equivalent Series Resistance) is high, the output may be unstable.

Notes: 1) If the output capacitor is set as equal or more than 2.2µF, output current is 0.01mA or lower than 0.01mA, noise level might be equal or more than 40µV. Considering frequency characteristics, fully evaluation is necessary.

Notes: 2) If the output capacitor is set as equal or less than 0.01µF, and the output current is 0.1mA or less, external noise caused by other circuits may affect on the device. Enforce the GND or fully countermeasure is necessary.

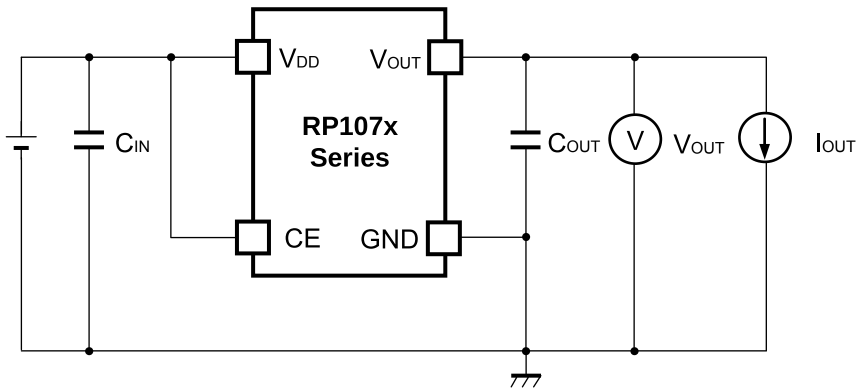
Please refer to the characteristics graph: external capacitor vs. output voltage.



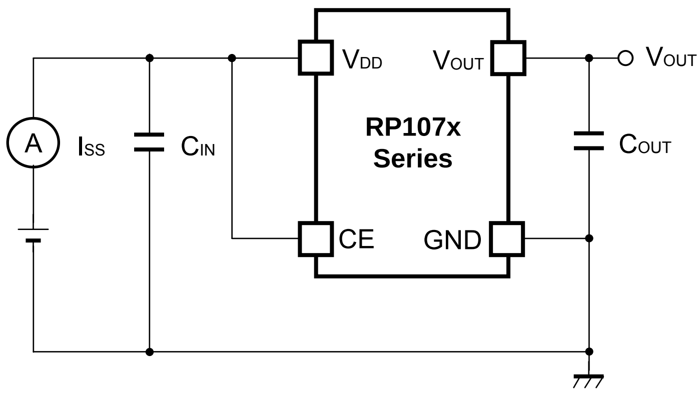
PCB Layout

Make V_{DD} and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor C_{IN} with a capacitance value as much as 0.1µF or more between V_{DD} and GND pin, and as close as possible to the pins.

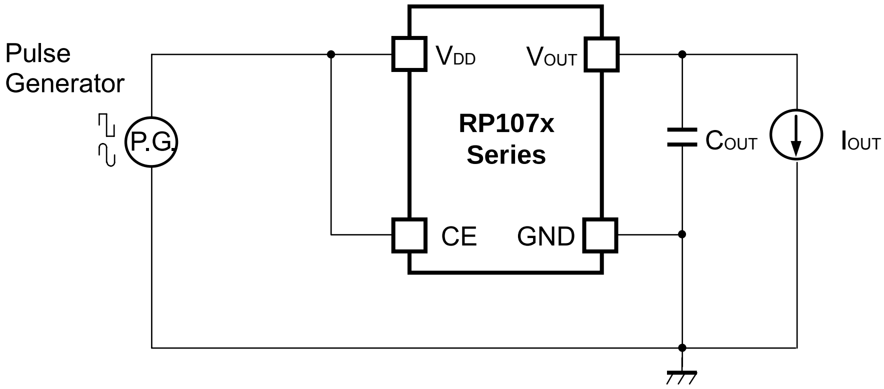
TEST CIRCUITS



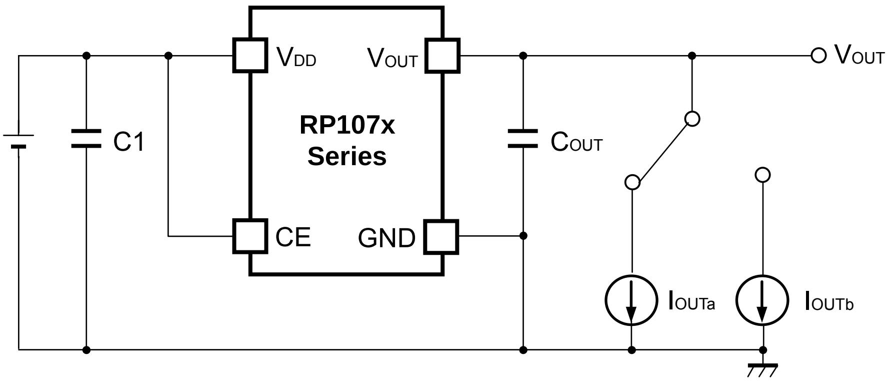
Basic Test Circuit



Test Circuit for Supply Current



Test Circuit for Ripple Rejection



Test Circuit for Load Transient Response

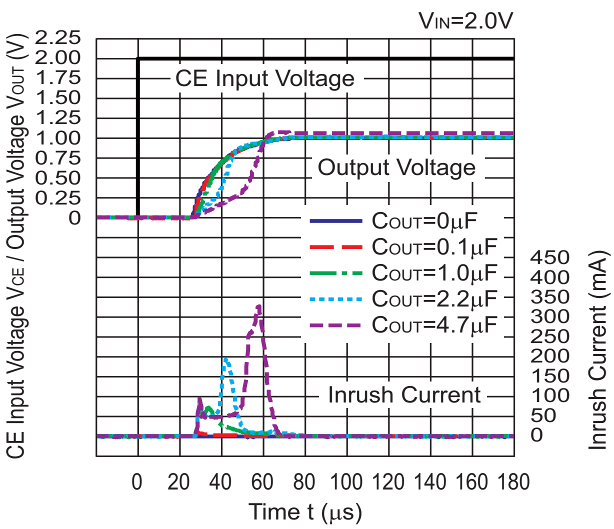
■ Constant Slope Circuits

The RP107x Series is equipped with a constant slope circuit as a soft-start circuit, which allows the output voltage to start up gradually when the CE is turned on.The constant slope circuit minimizes the inrush current at the start-up and also prevents the overshoot of the output voltage.The capacitor to create the start-up slope is built in the IC that does not require any external components. The start-up time and the start-up slope angle are fixed inside the IC.

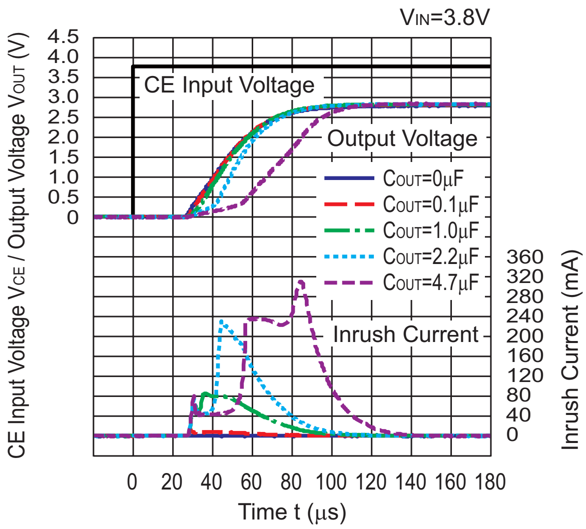
If the capacitance of the external output capacitor (C_{OUT}) becomes more than the certain capacitance, the output current limit circuit minimizes the incoming current of the output capacitor at the start-up. As a result, the start-up time becomes longer and the start-up slope angle becomes more gentle. As "Inrush Current Characteristics Example" below shows, if the C_{OUT} is less than 2.2μF, the constant slope circuit easily starts to function at the start-up, likewise, if the C_{OUT} is over 4.7μF, the output current limit circuit easily starts to function at the start-up. The boundary point of using these two circuits is inversely proportional to the output voltage. If the output voltage is higher, the output current limit circuit easily starts to function even if the C_{OUT} capacitance is small. For more details, please refer to the graph 15 of "Inrush Current Characteristics Example".

Inrush Current Characteristics Example (C1=0.1μF, Topt=25°C)

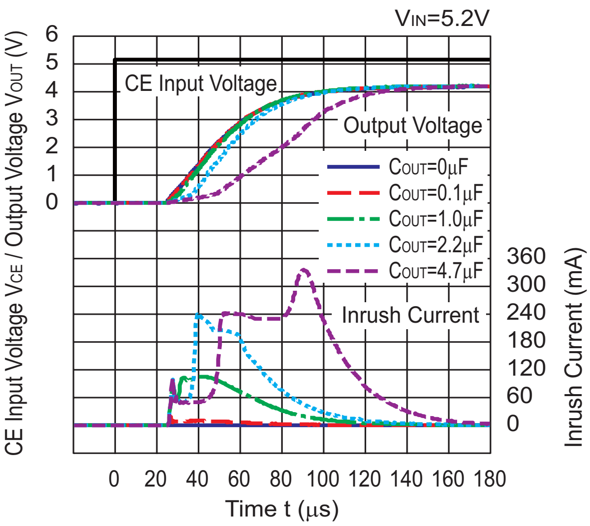
RP107x101xB/D



RP107x281xB/D



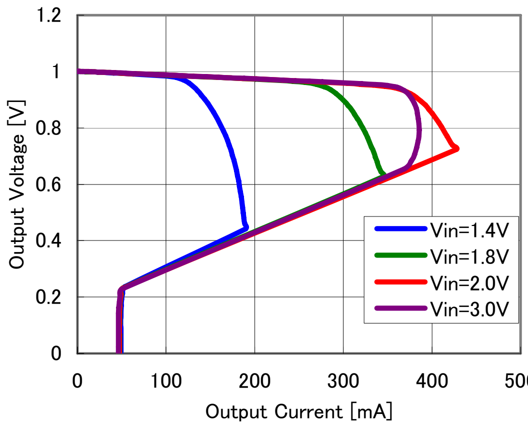
RP107x421xB/D



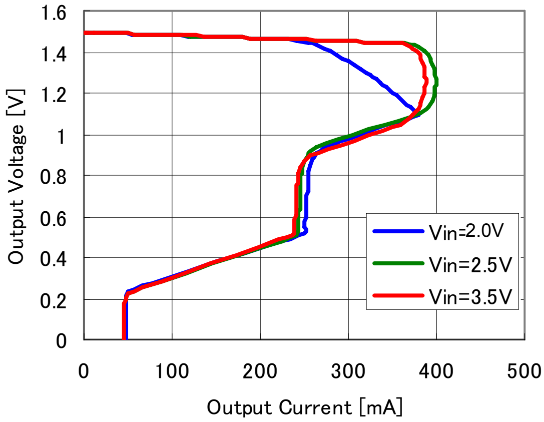
TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current (C_{IN}=0.1µF, Topt=25°C)

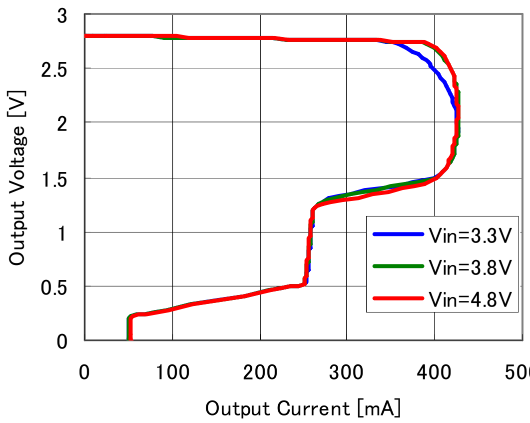
RP107x101x



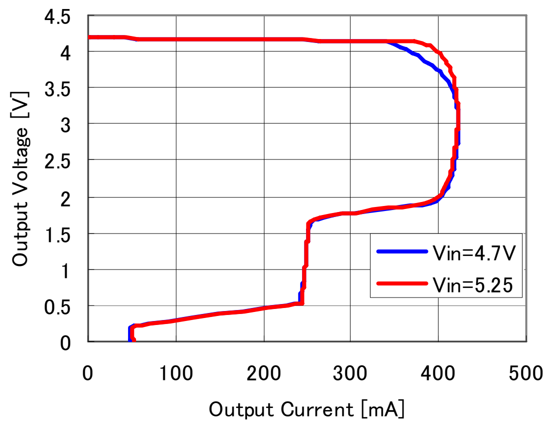
RP107x151x



RP107x281x

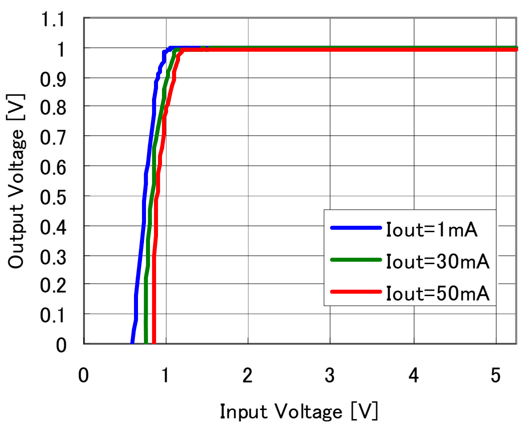


RP107x421x



2) Output Voltage vs. Input Voltage (C_{IN}=0.1µF, Topt=25°C)

RP107x101x



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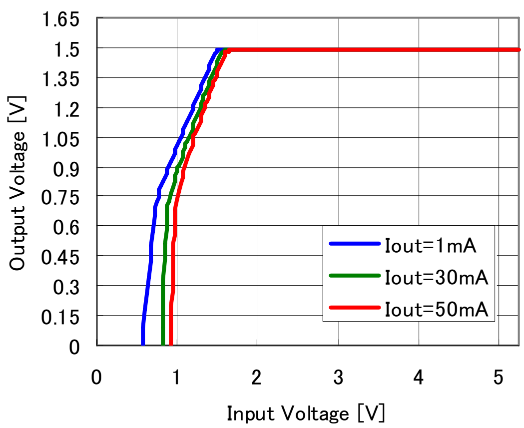

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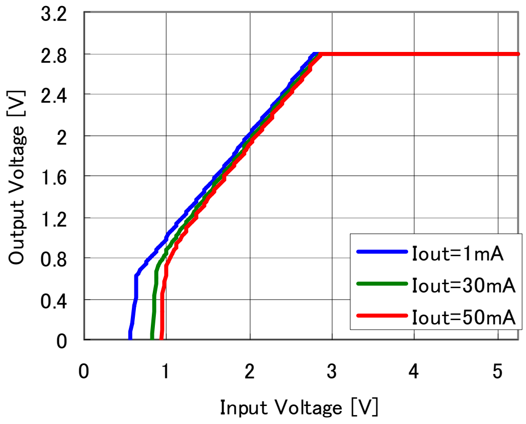

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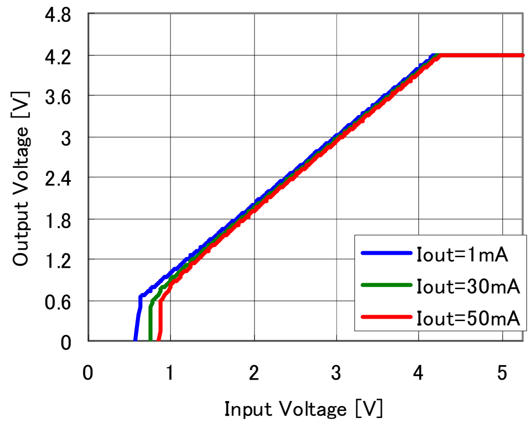
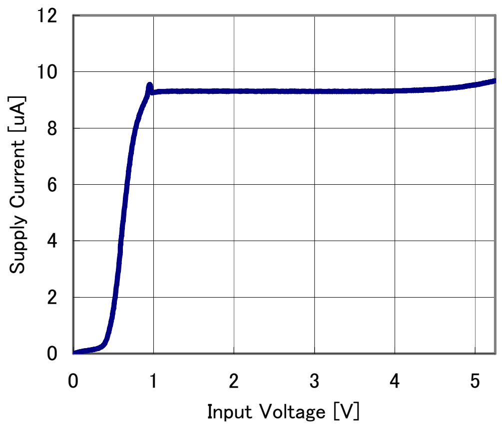


3) Supply Current vs. Input Voltage (C_{IN}=0.1μF, T_{opt}=25°C)

RP107x101x



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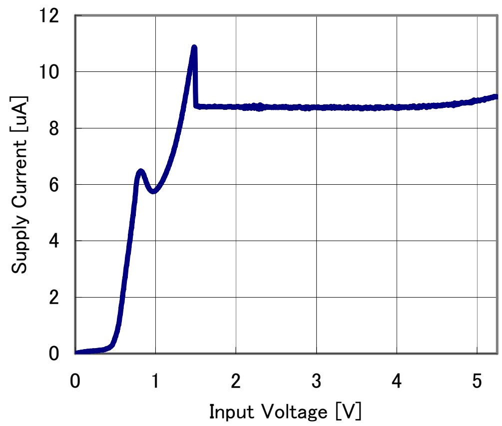

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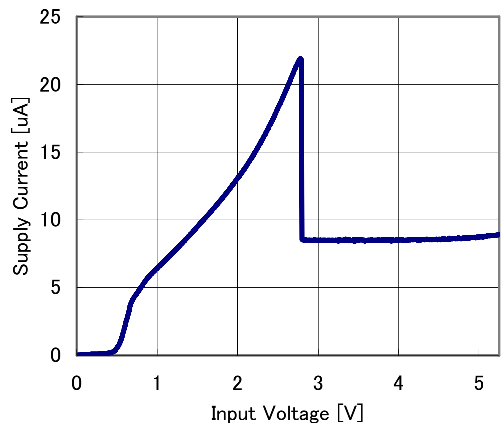

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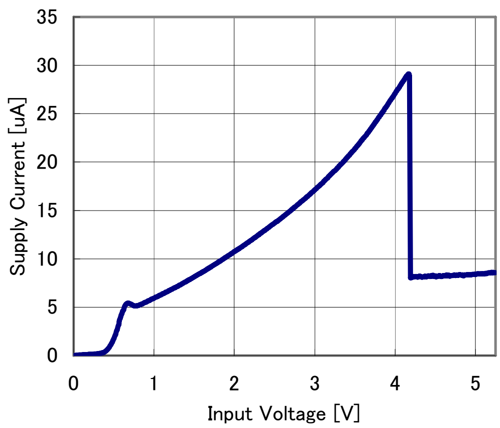
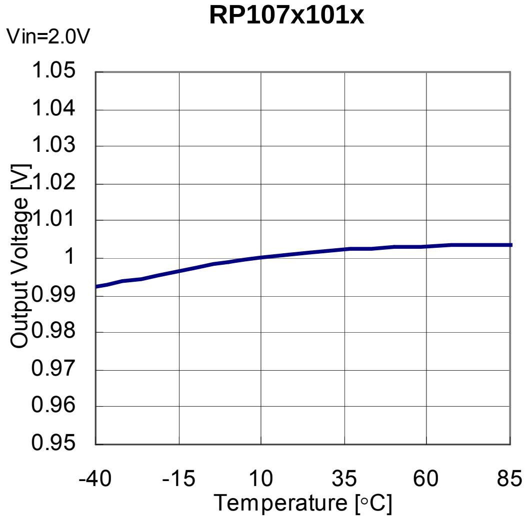


4) Output Voltage vs. Temperature (C_{IN}=0.1µF, I_{OUT}=1mA)

RP107x101x



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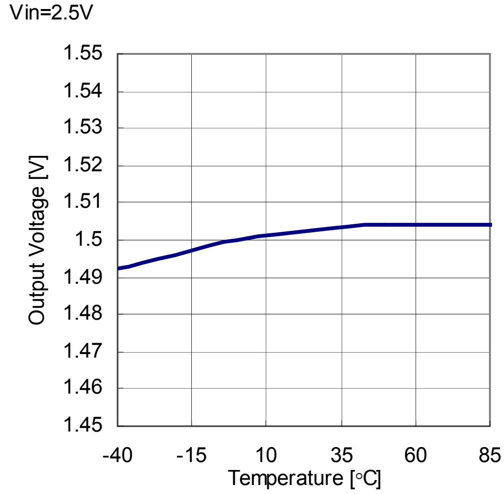

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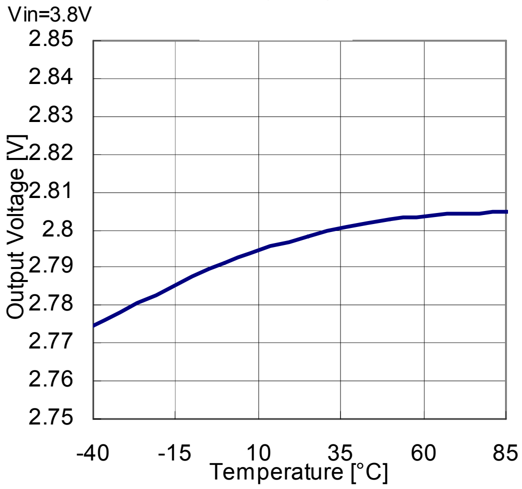

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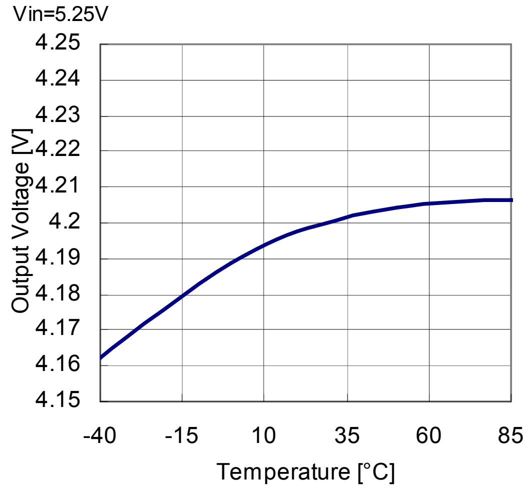
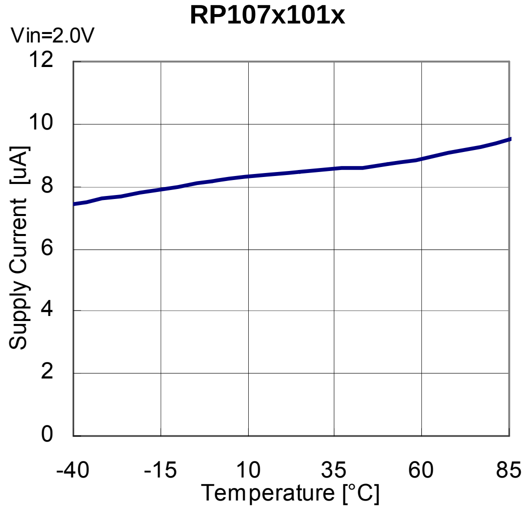


5) Supply Current vs. Temperature (C_{IN}=0.1µF, I_{OUT}=0mA)

RP107x101x



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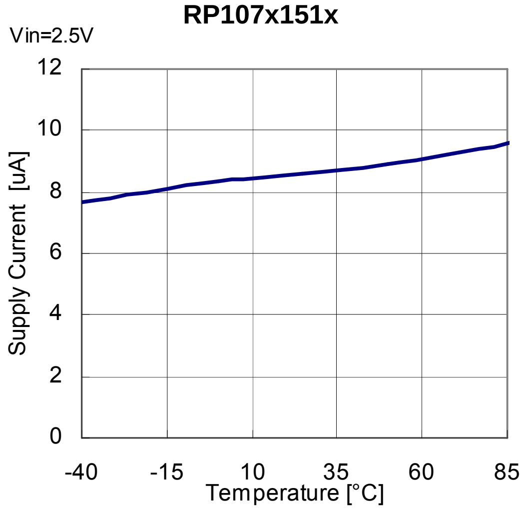

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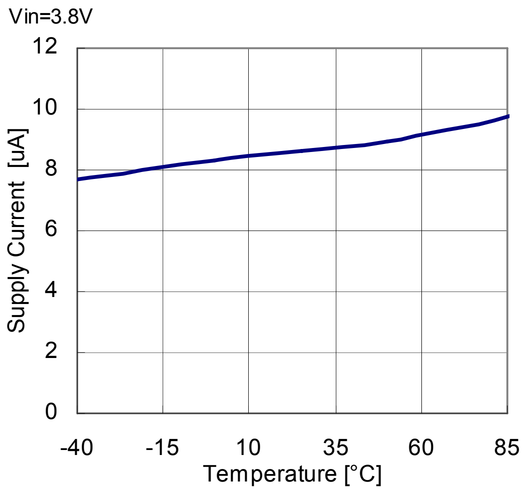

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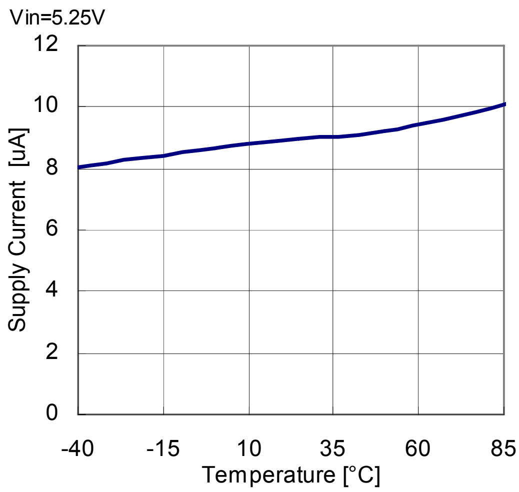
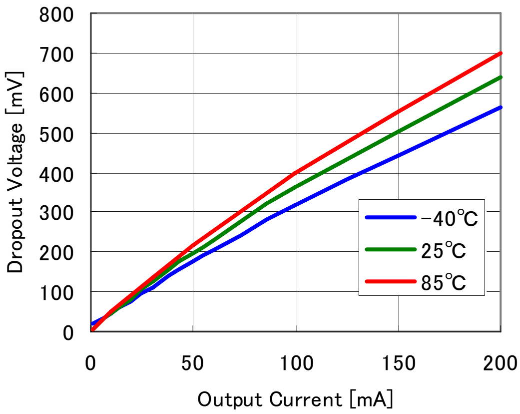
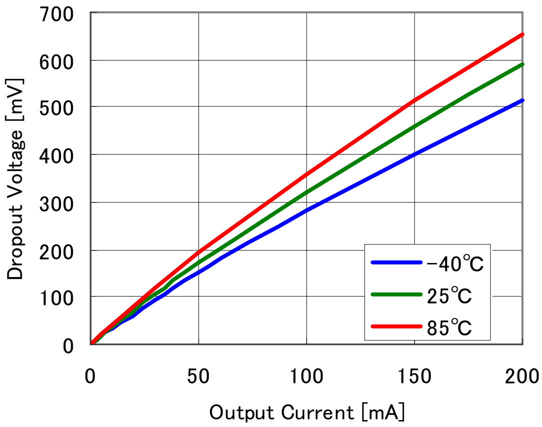


6) Dropout Voltage vs. Output Current (C_{IN}=0.1μF)

RP107x101x



RP107x111x



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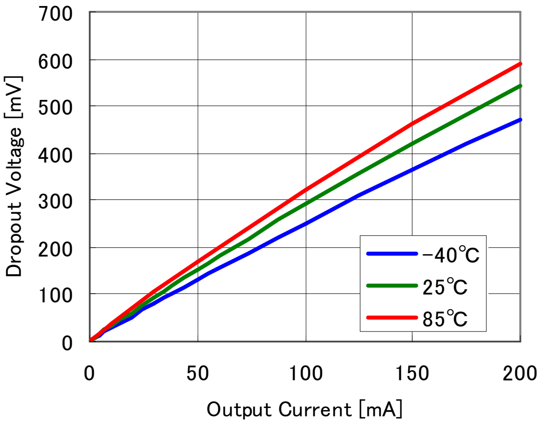

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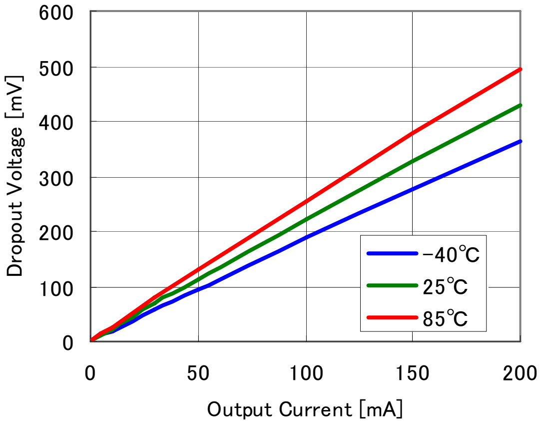
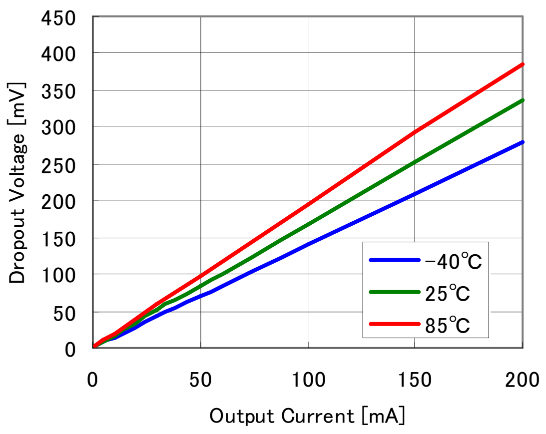
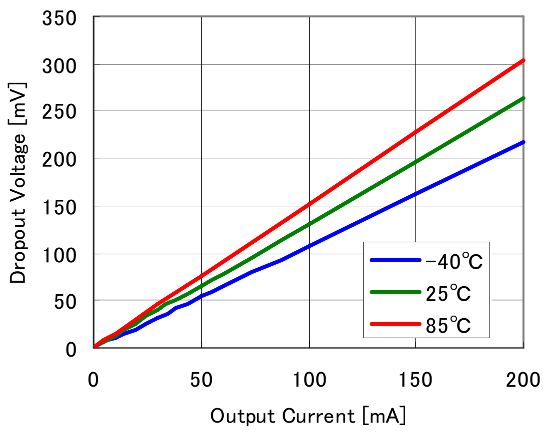


RP107x201x



RP107x301x



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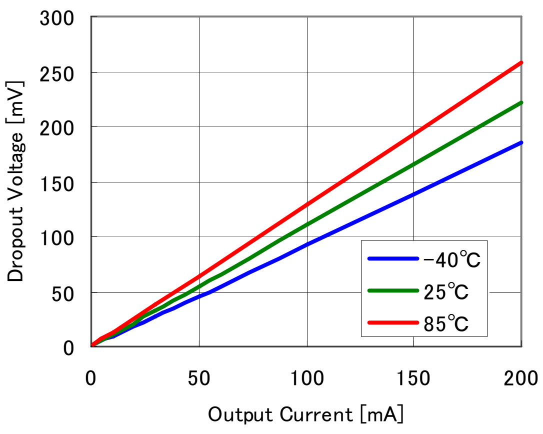
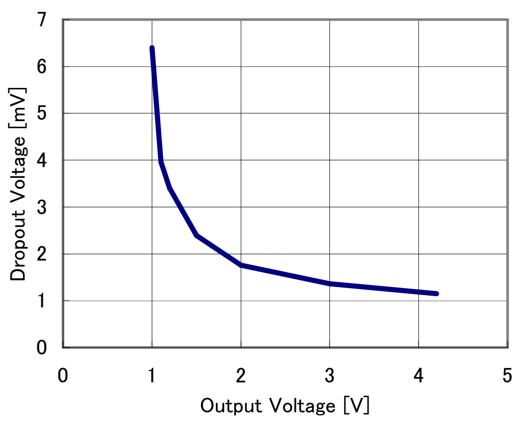


7) Dropout Voltage vs. Set Output Voltage (C_{IN}=0.1µF)

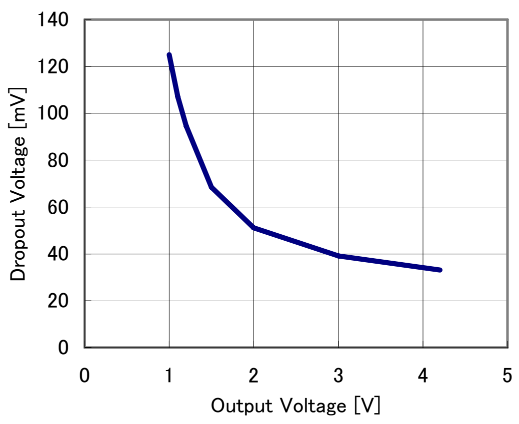
RP107x

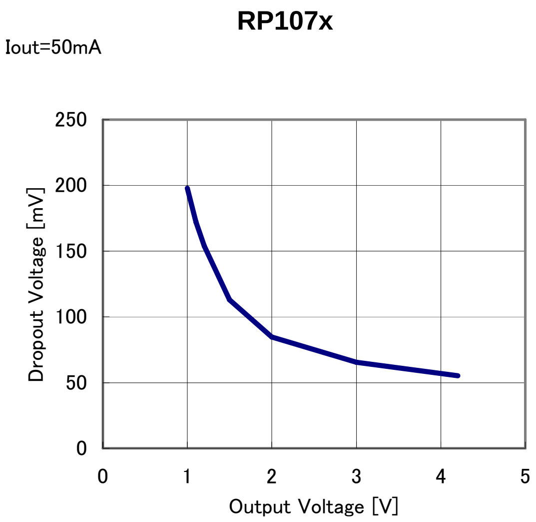
Iout=1mA

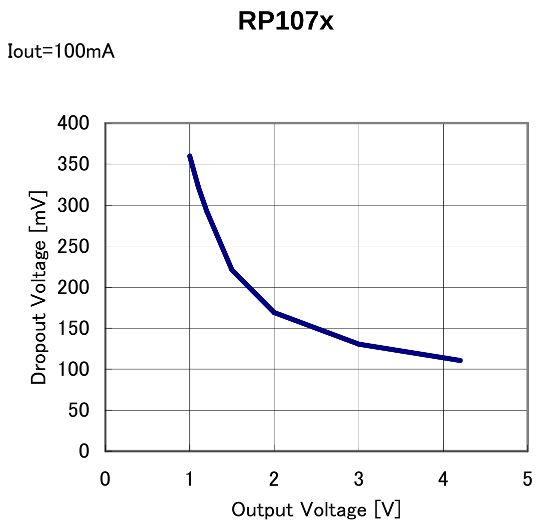


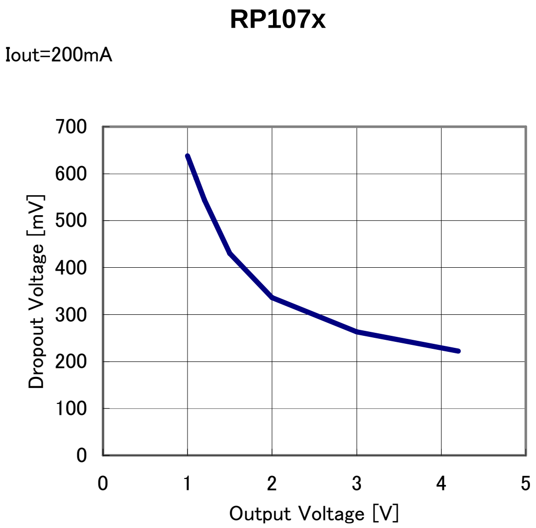
RP107x

Iout=30mA

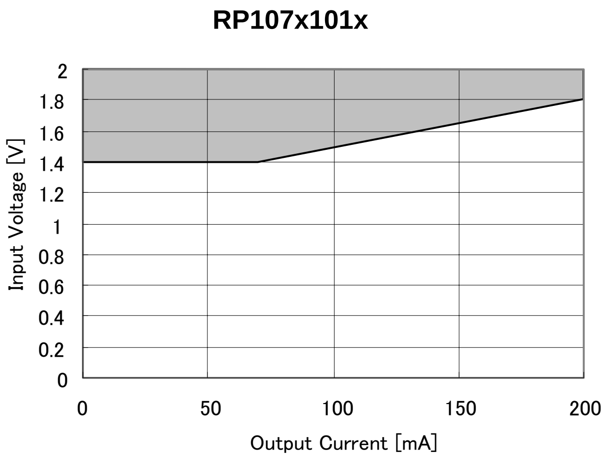








8) Minimum Operating Voltage (C_{IN}=0.1μF)

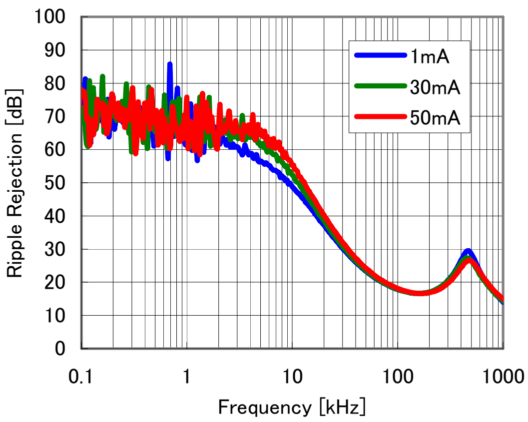


Hatched area is avaiable
for 1.0V output

9) Ripple Rejection vs. Frequency (CIN=none, Topt=25°C)

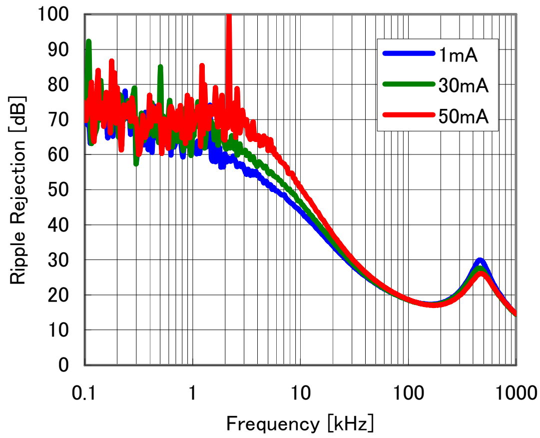
RP107x101x

Vin=2.0V+0.2Vp-p Cout=none



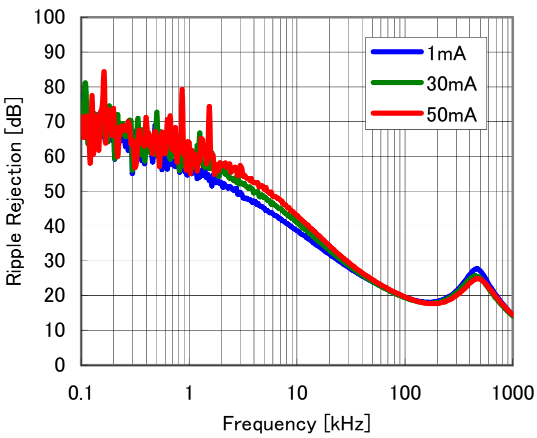
RP107x151x

Vin=2.5V+0.2Vp-p Cout=none



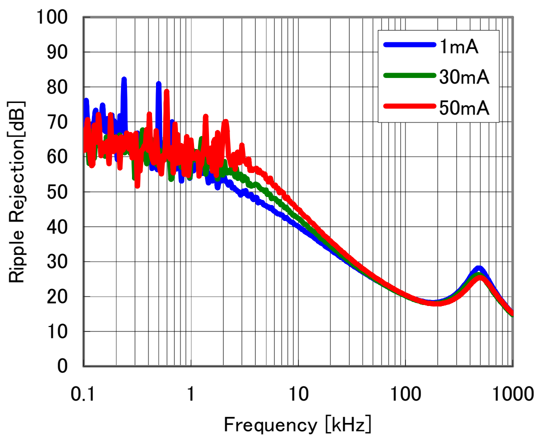
RP107x281x

Vin=3.8V+0.2Vp-p Cout=none



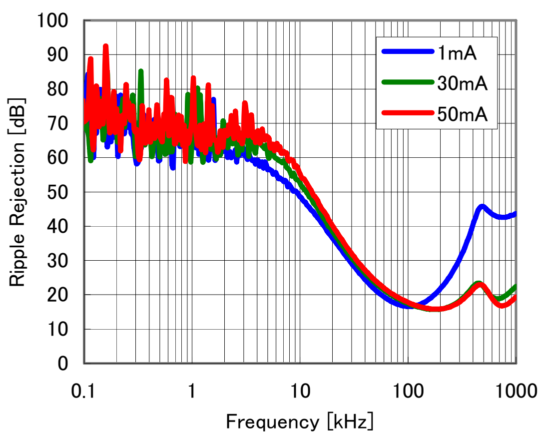
RP107x421x

Vin=5.2V+0.2Vp-p Cout=none



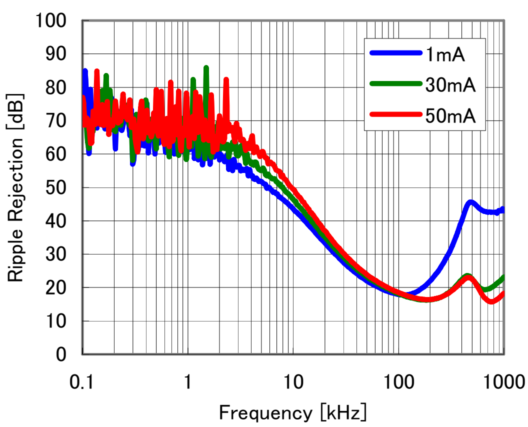
RP107x101x

Vin=2.0V+0.2Vp-p Cout=0.1uF



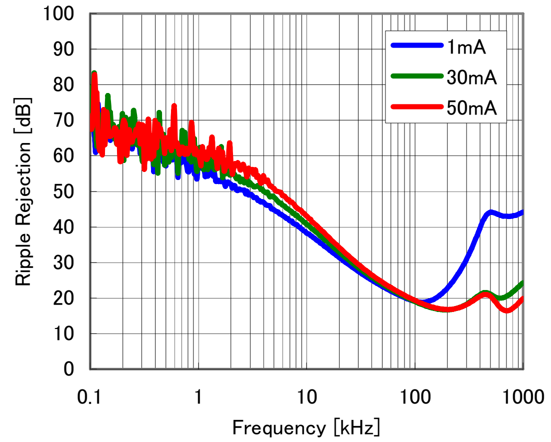
RP107x151x

Vin=2.5V+0.2Vp-p Cout=0.1uF



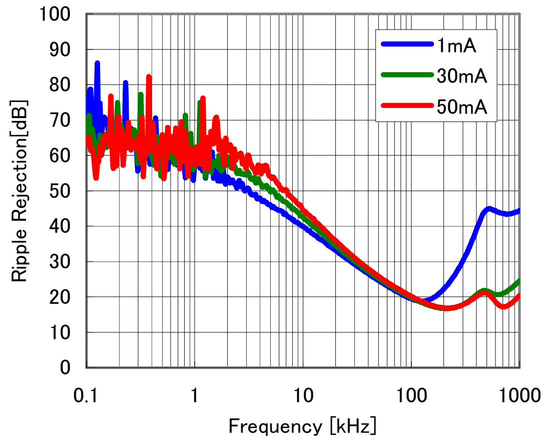
RP107x281x

Vin=3.8V+0.2Vp-p Cout=0.1uF



RP107x421x

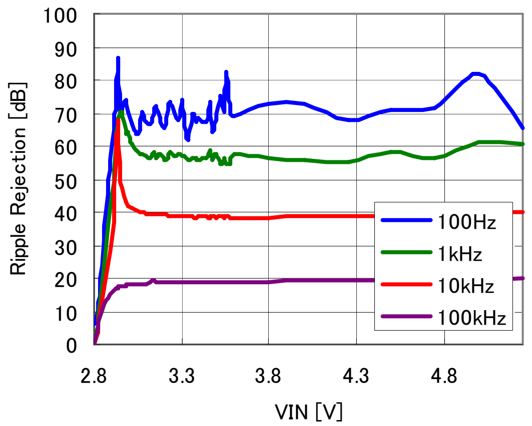
Vin=5.2V+0.2Vp-p Cout=0.1uF



10) Ripple Rejection vs. Input Bias Voltage (COUT=0.1μF, Ripple=0.2Vp-p, Topt=25°C)

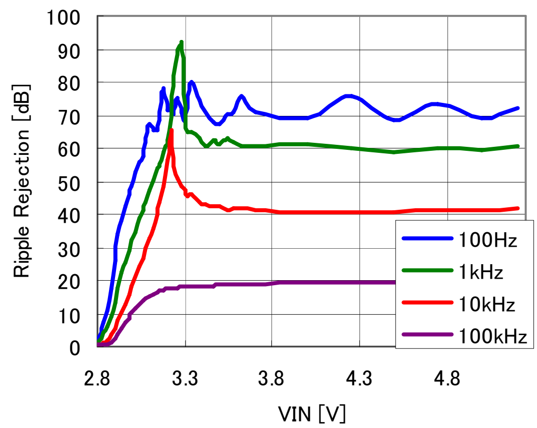
RP107x281x

Iout=1mA



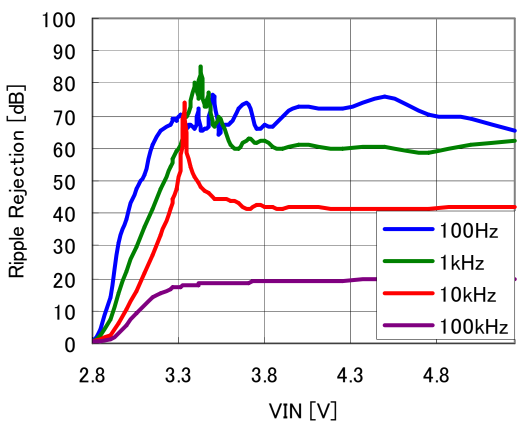
RP107x281x

Iout=30mA



RP107x281x

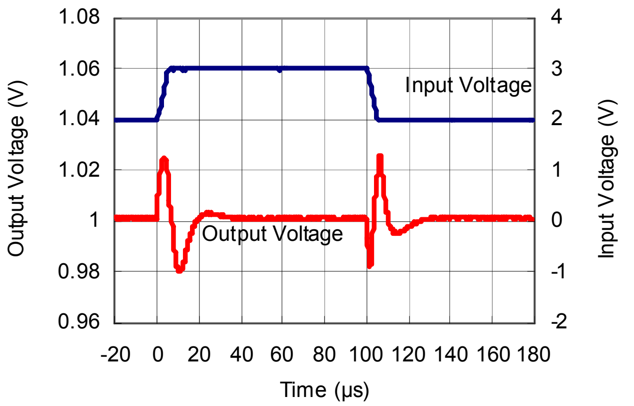
Iout=50mA



11) Input Transient Response (C_{IN}=none, I_{OUT}=30mA, tr=tf=5μs, T_{opt}=25°C)

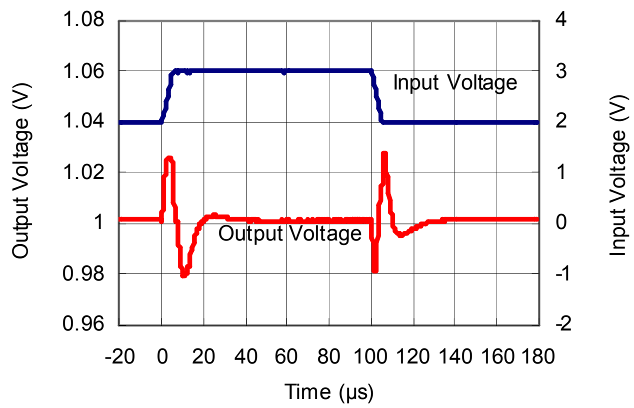
RP107x101x

Vin:2V⇔3V Cout=none



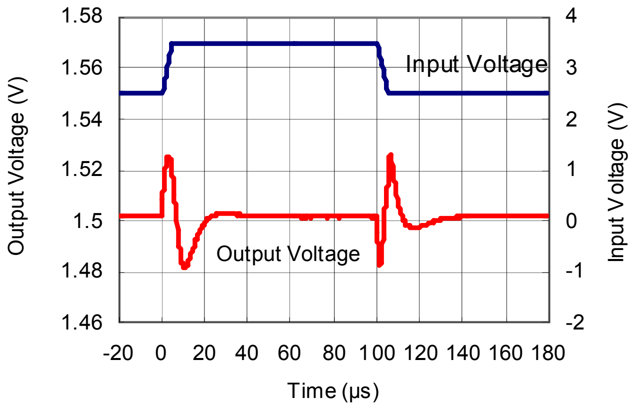
RP107x101x

Vin:2V⇔3V Cout=Ceramic 0.1uF



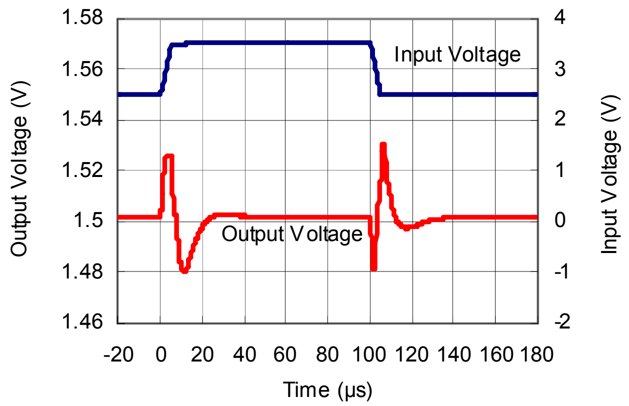
RP107x151x

Vin:2.5V⇔3.5V Cout=none



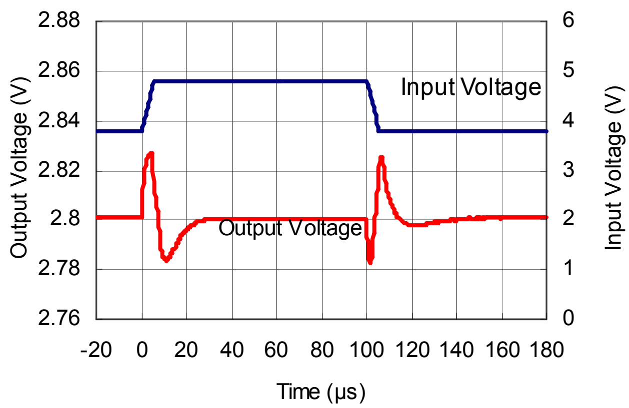
RP107x151x

Vin:2.5V⇔3.5V Cout=Ceramic 0.1μF



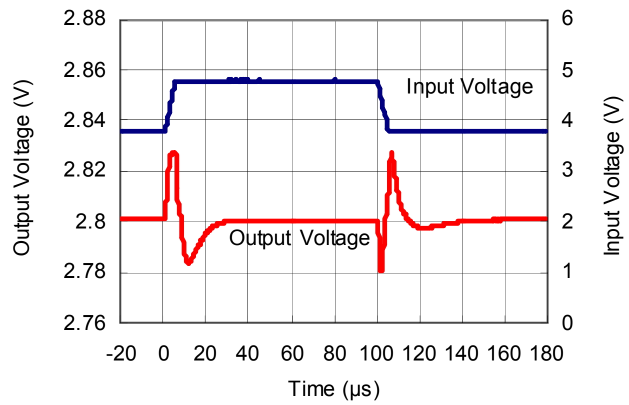
RP107x281x

Vin:3.8V⇔4.8V Cout=none



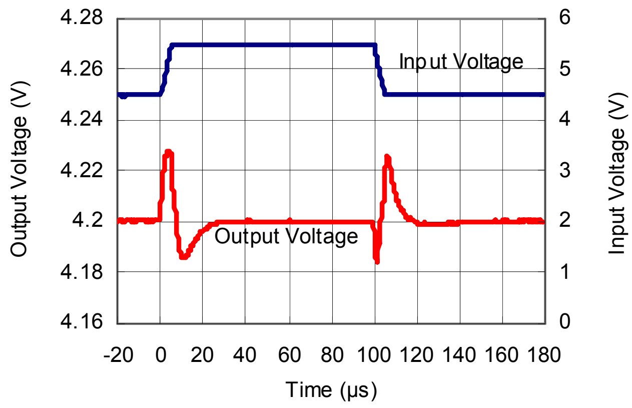
RP107x281x

Vin:3.8V⇔4.8V Cout=Ceramic 0.1μF



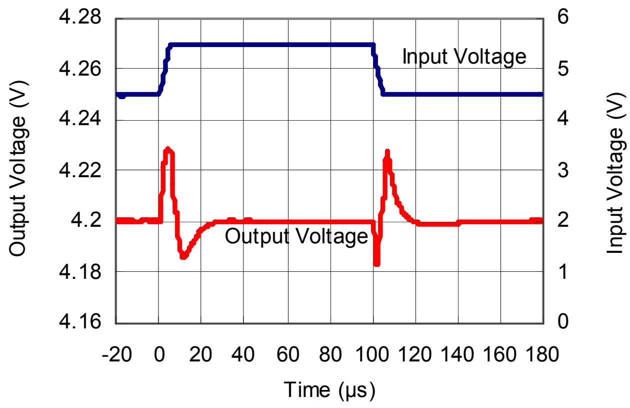
RP107x421x

Vin:4.5V⇔5.5V Cout=none



RP107x421x

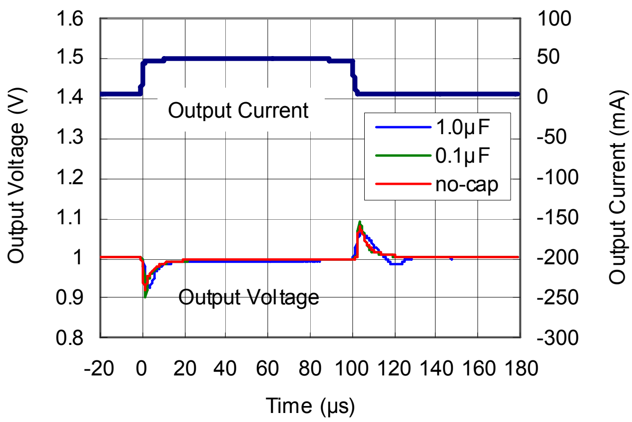
Vin:4.5V⇔5.5V Cout=Ceramic 0.1μF



12) Load Transient Response (C_{IN}=0.1μF, Topt=25°C)

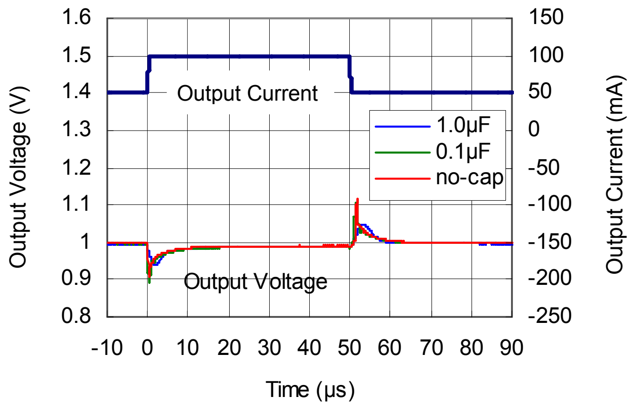
RP107x101x

Tr=Tf: 2μs
Iout : 5mA⇔50mA



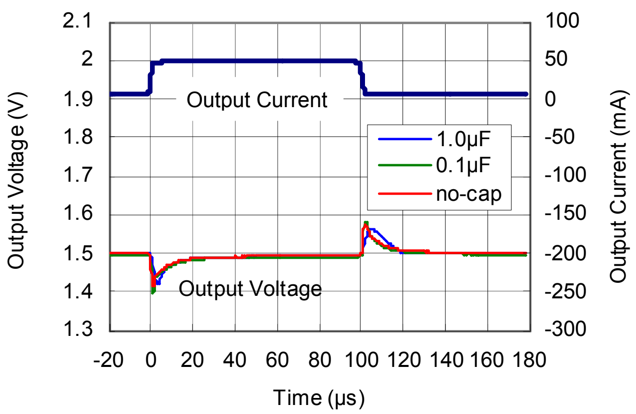
RP107x101x

Tr=Tf : 0.5μs
Iout : 50mA⇔100mA



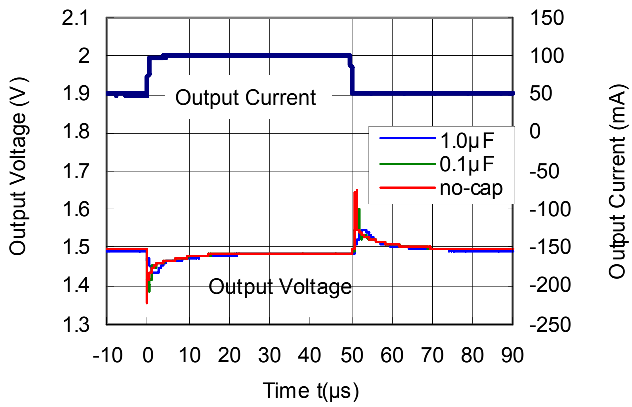
RP107x151x

Tr=Tf : 2μs
Iout : 5mA⇔50mA

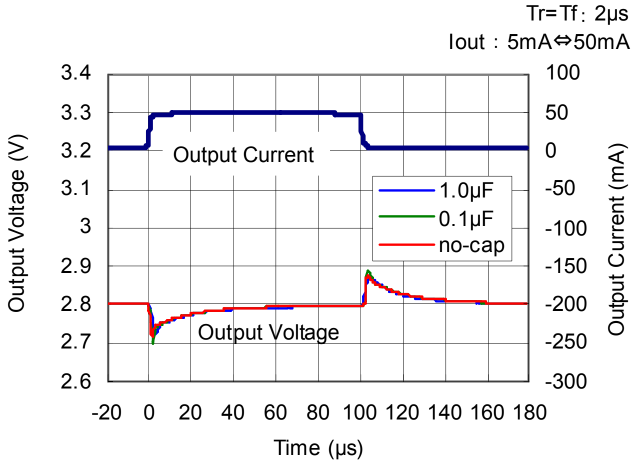


RP107x151x

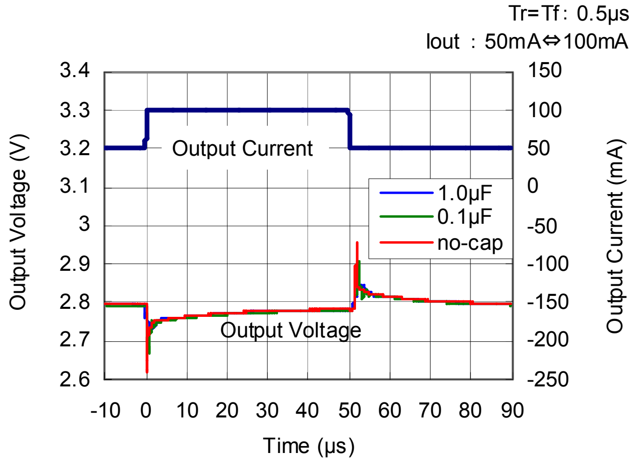
Tr=Tf : 0.5μs
Iout : 50mA⇔100mA



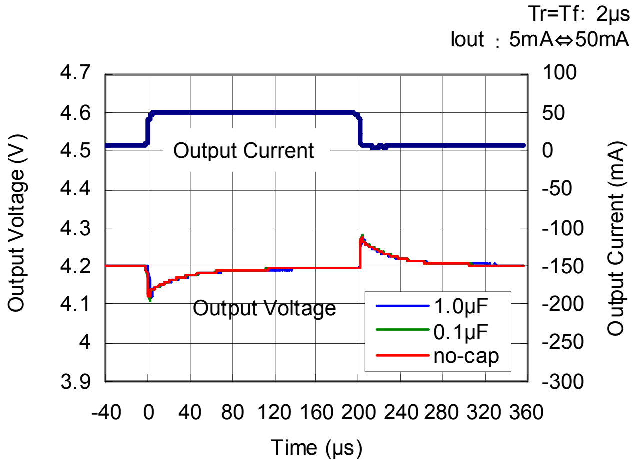
RP107x281x



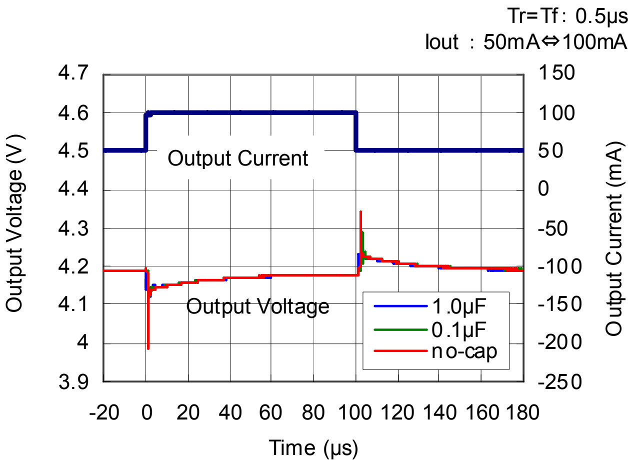
RP107x281x



RP107x421x

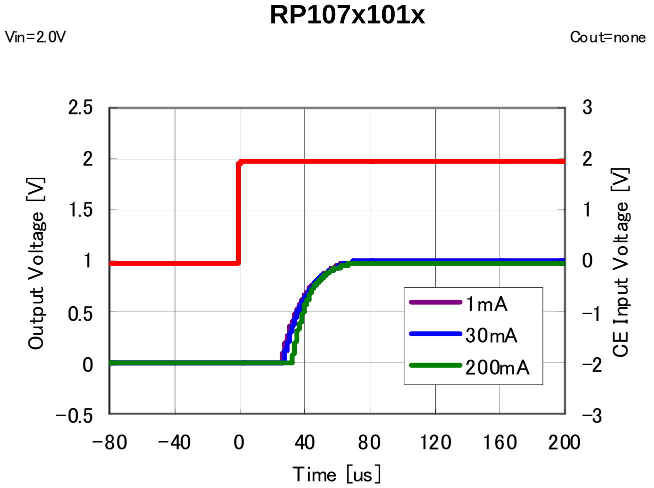


RP107x421x

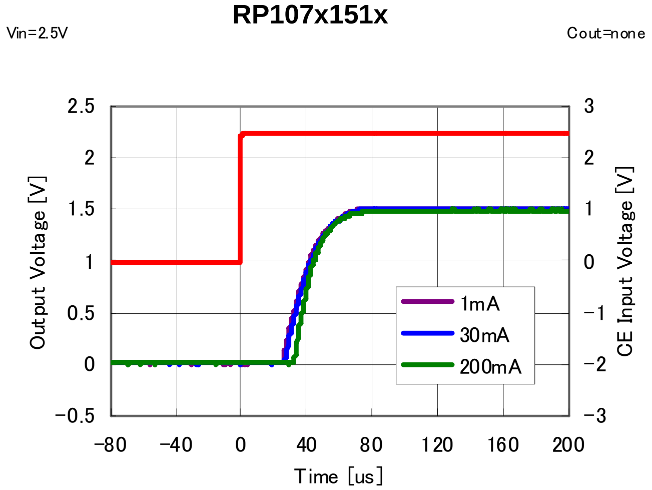


13) Turn On Speed with CE pin (C_{IN}=0.1μF, T_{opt}=25°C)

RP107x101x

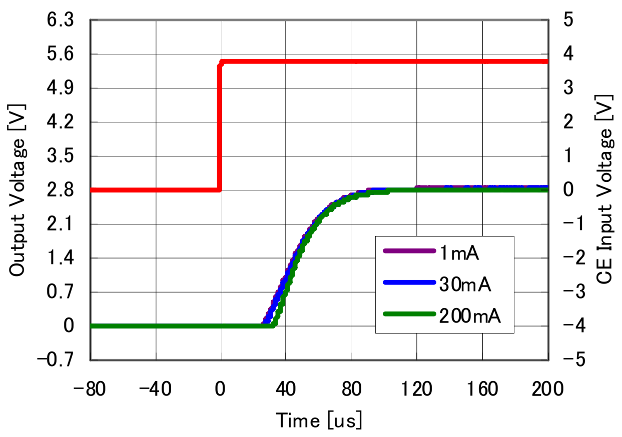


RP107x151x



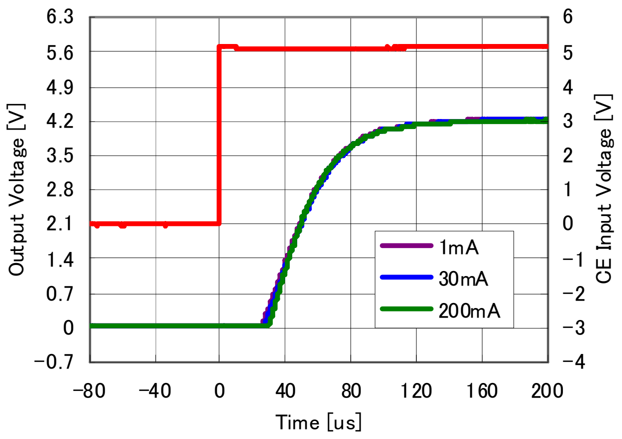
RP107x281x

Vin=3.8V Cout=none



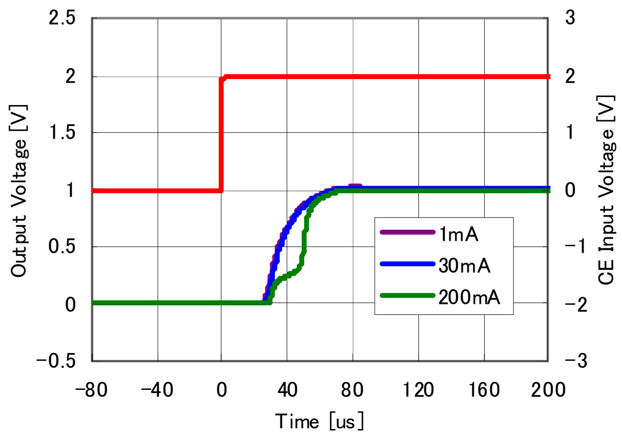
RP107x421x

Vin=5.2V Cout=none



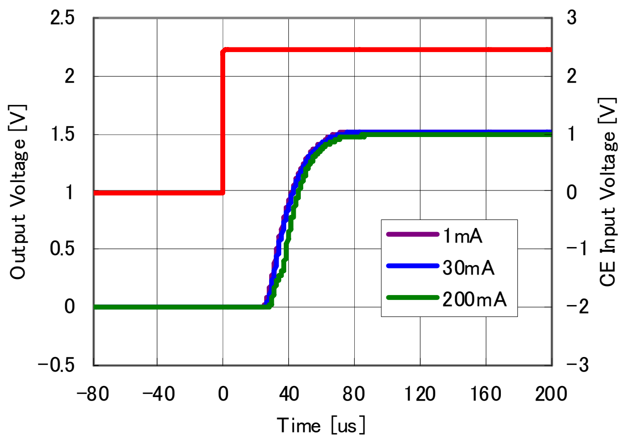
RP107x101x

Vin=2.0V Cout=1uF



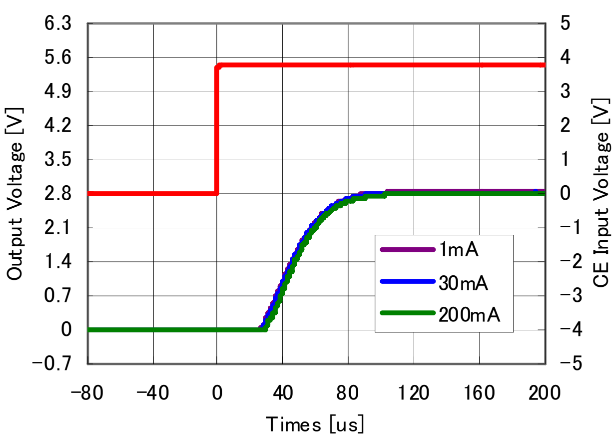
RP107x151x

Vin=2.5V Cout=1uF



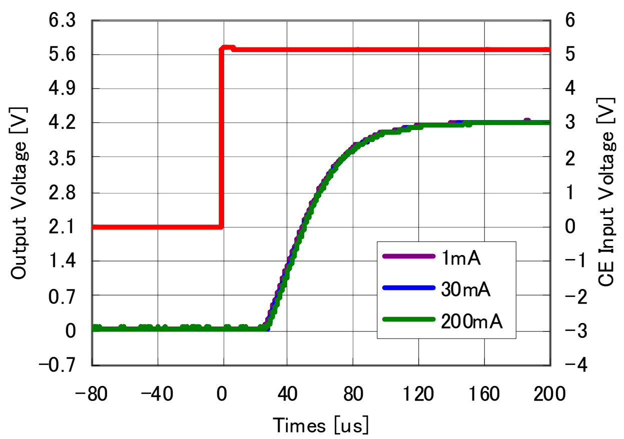
RP107x281x

Vin=3.8V Cout=1uF



RP107x421x

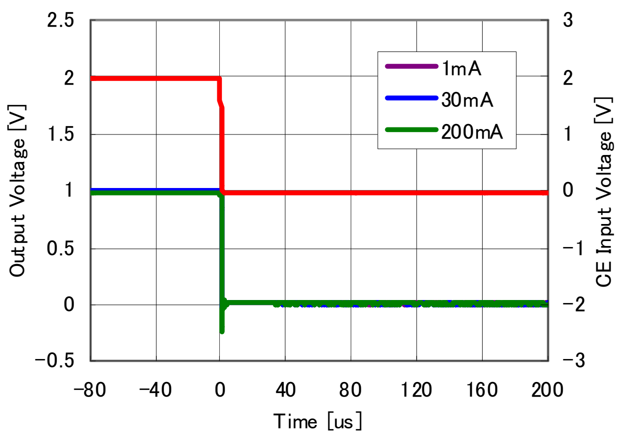
Vin=5.2V Cout=1uF



14) Turn Off Speed with CE pin (D Version) (C_{IN}=0.1µF, T_{opt}=25°C)

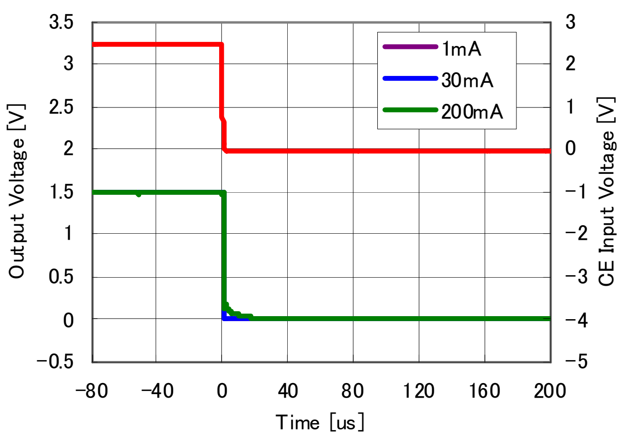
RP107x101D

Vin=2.0V Cout=none



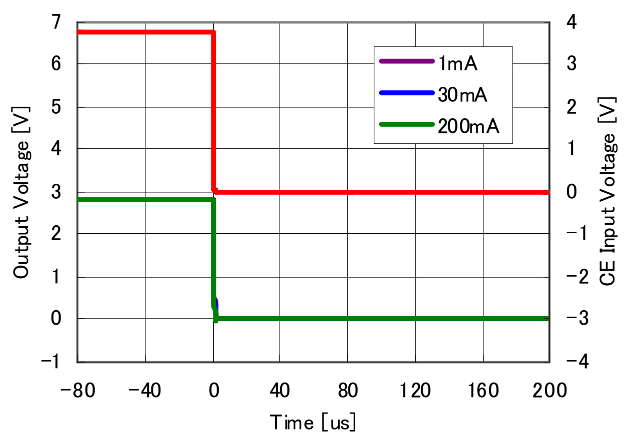
RP107x151D

Vin=2.5V Cout=none



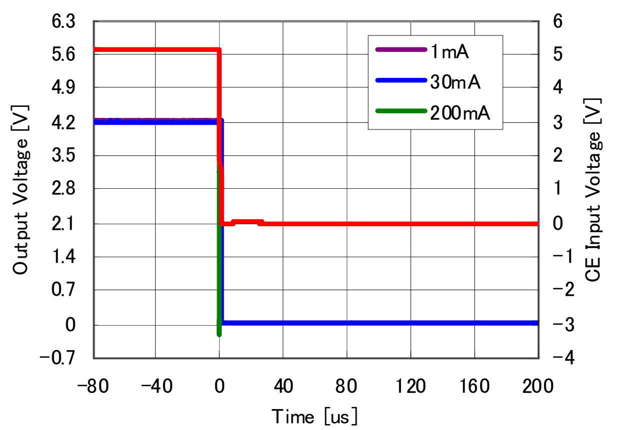
RP107x281D

Vin=3.8V Cout=none



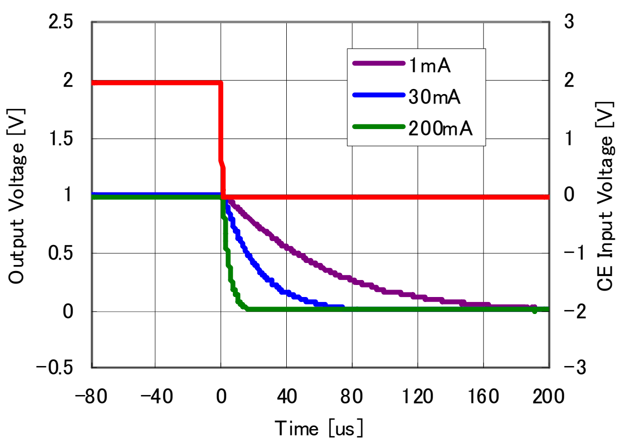
RP107x421D

Vin=5.2V Cout=none



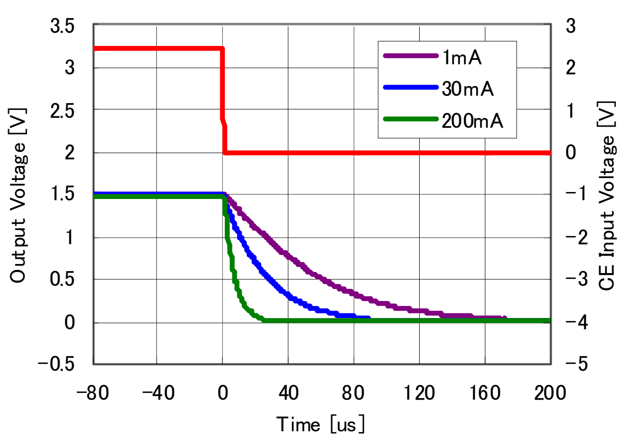
RP107x101D

Vin=2.0V Cout=1uF

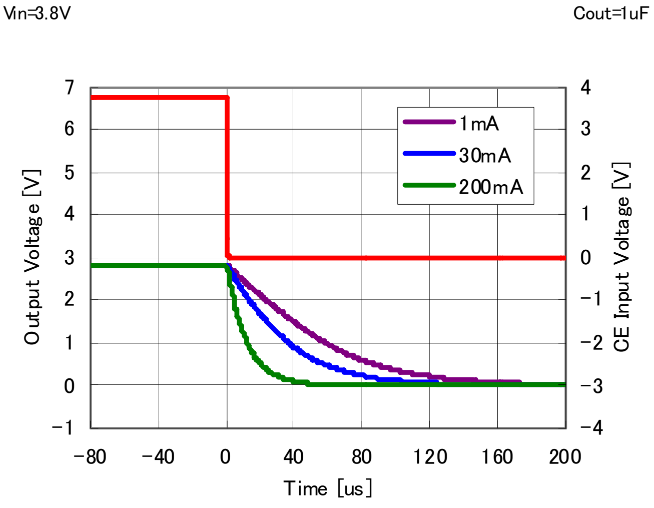


RP107x151D

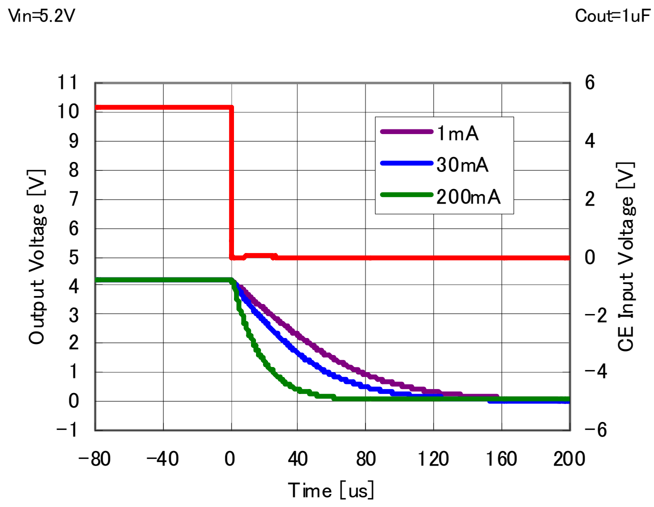
Vin=2.5V Cout=1uF



RP107x281D

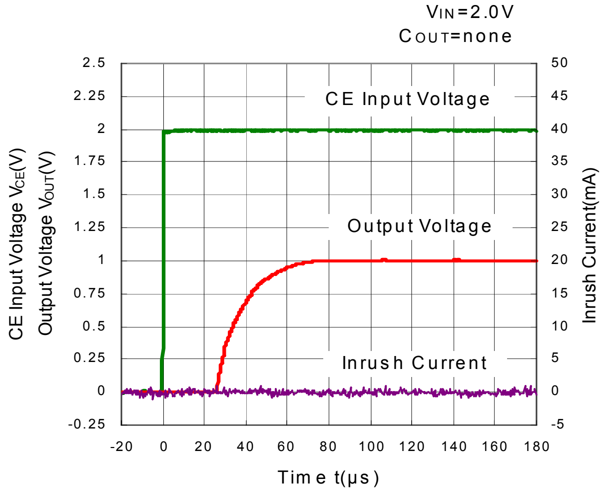


RP107x421D

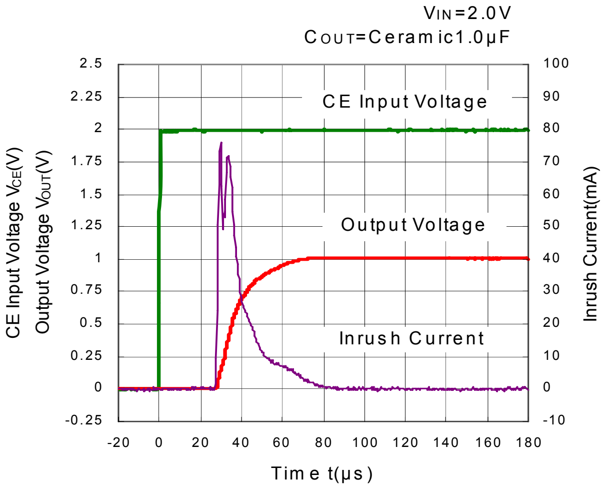


15) Inrush Current (C_{IN}=0.1μF, Topt=25°C)

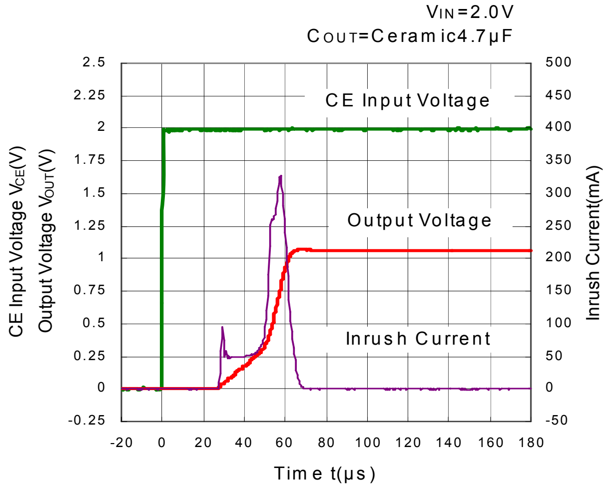
RP107x101x



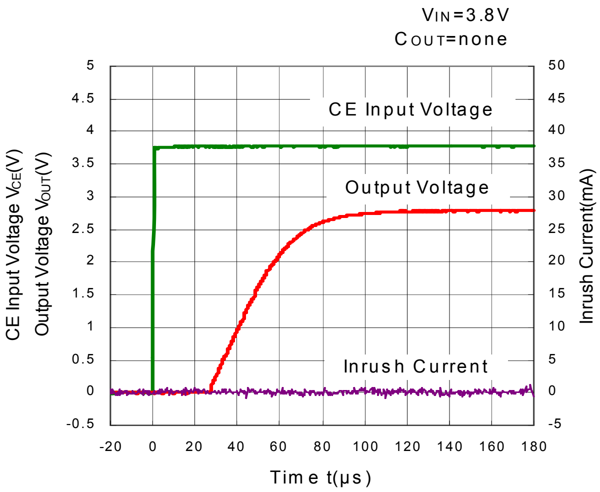
RP107x101x

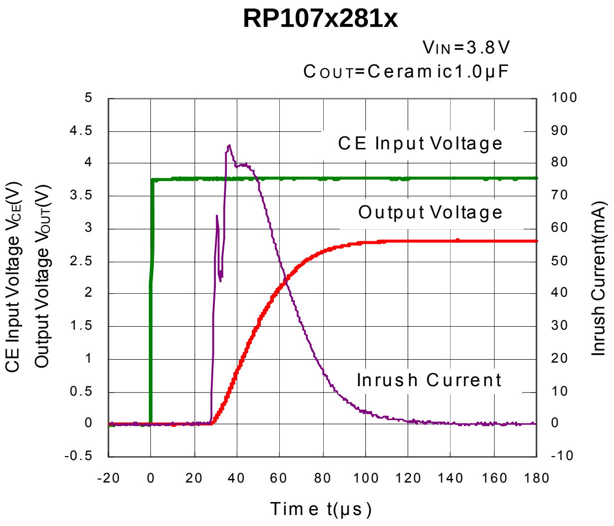


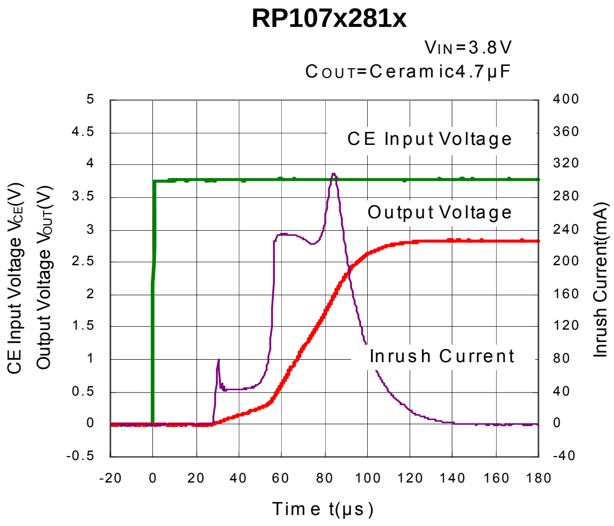
RP107x101x

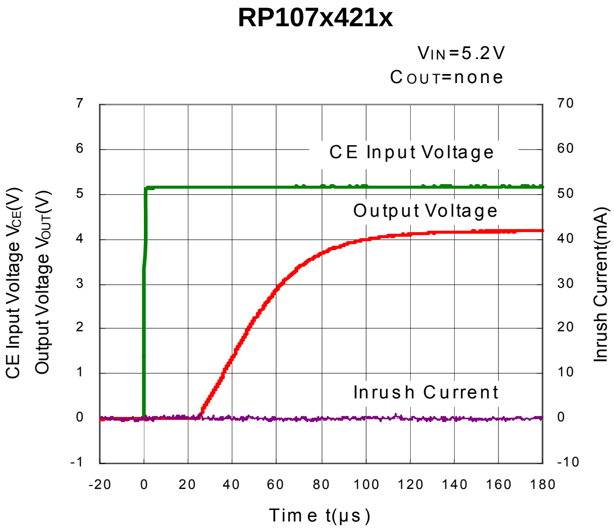


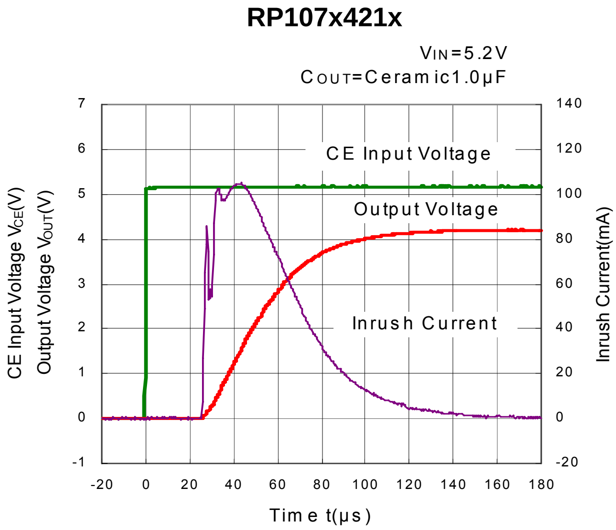
RP107x281x

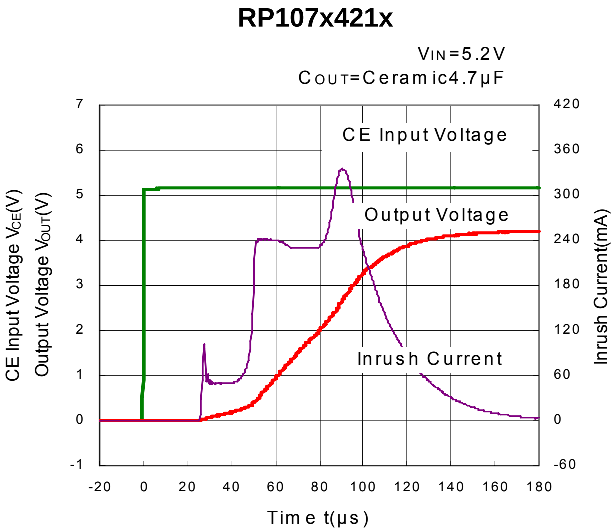



RP107x281x
VIN=3.8V
COUT=Ceramic1.0μF
CE Input Voltage
Output Voltage
Inrush Current
CE Input Voltage VCE(V)
Output Voltage VOUT(V)
Inrush Current(mA)
Time t(μs)


RP107x281x
VIN=3.8V
COUT=Ceramic4.7μF
CE Input Voltage
Output Voltage
Inrush Current
CE Input Voltage VCE(V)
Output Voltage VOUT(V)
Inrush Current(mA)
Time t(μs)


RP107x421x
VIN=5.2V
COUT=none
CE Input Voltage
Output Voltage
Inrush Current
CE Input Voltage VCE(V)
Output Voltage VOUT(V)
Inrush Current(mA)
Time t(μs)


RP107x421x
VIN=5.2V
COUT=Ceramic1.0μF
CE Input Voltage
Output Voltage
Inrush Current
CE Input Voltage VCE(V)
Output Voltage VOUT(V)
Inrush Current(mA)
Time t(μs)


RP107x421x
VIN=5.2V
COUT=Ceramic4.7μF
CE Input Voltage
Output Voltage
Inrush Current
CE Input Voltage VCE(V)
Output Voltage VOUT(V)
Inrush Current(mA)
Time t(μs)

ESR vs. Output Current

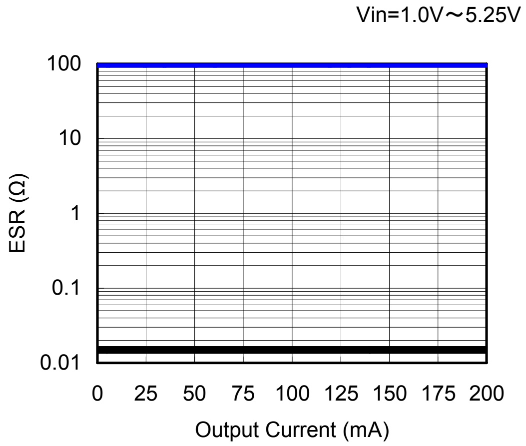
When using these ICs, consider the following points:

The relations between I_{OUT} (Output Current) and ESR of an output capacitor are shown below.
The conditions when the white noise level is under 40µV (Avg.) are marked as the hatched area in the graph.

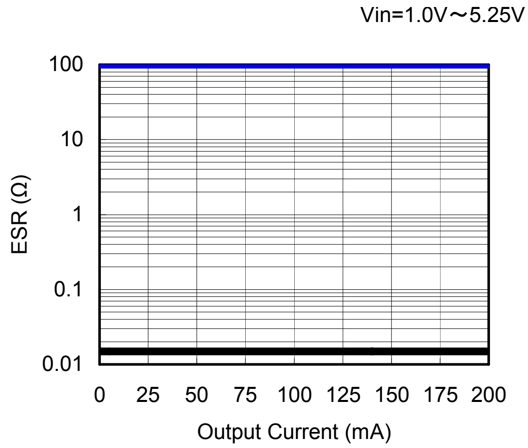
Measurement conditions

Frequency Band : 10Hz to 2MHz
Temperature : –40°C to 85°C
C_{IN}, C_{OUT} : Ceramic 0.1µF

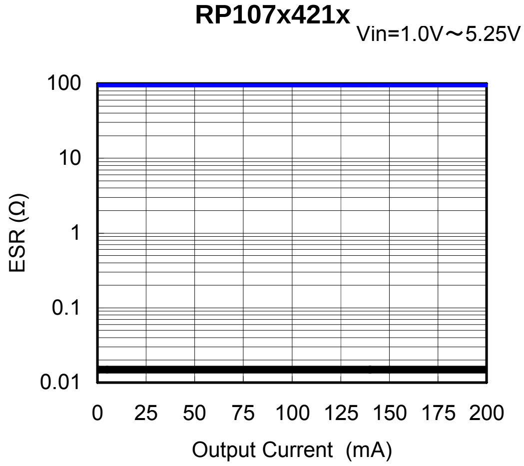
RP107x101x



RP107x281x



RP107x421x



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6. We are making our continuous effort to improve the quality and reliability of our products, but semiconductor products are likely to fail with certain probability. In order to prevent any injury to persons or damages to property resulting from such failure, customers should be careful enough to incorporate safety measures in their design, such as redundancy feature, firecontainment feature and fail-safe feature. We do not assume any liability or responsibility for any loss or damage arising from misuse or inappropriate use of the products.
7. Anti-radiation design is not implemented in the products described in this document.
8. Please contact Ricoh sales representatives should you have any questions or comments concerning the products or the technical information.

RICOH COMPANY., LTD. Electronic Devices Company

日本経営品質賞 1999年度受賞

■Ricoh presented with the Japan Management Quality Award for 1999.
Ricoh continually strives to promote customer satisfaction, and shares the achievements of its management quality improvement program with people and society.

■Ricoh awarded ISO 14001 certification.
The Ricoh Group was awarded ISO 14001 certification, which is an international standard for environmental management systems, at both its domestic and overseas production facilities. Our current aim is to obtain ISO 14001 certification for all of our business offices.

RoHS Compliant

Ricoh completed the organization of the Lead-free production for all of our products. After Apr. 1, 2006, we will ship out the lead free products only. Thus, all products that will be shipped from now on comply with RoHS Directive.

http://www.ricoh.com/LSI/

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